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ABSTRACT

A study was conducted to determine: why teachers think the way they do; what teachers know and what is transferred to students; and, how novice teachers and experienced teachers alike attempt to make sense of the world. The subjects of the study were 117 elementary education student teachers. A pretest was administered prior to student teaching with respect to the novices' knowledge and beliefs about teaching as well as their views on teaching and learning through knowledge of content. A posttest was given upon completion of the student teaching experience. Among the findings of the study were: (1) student teachers view knowledge as more than factual content; and (2) knowledge becomes an understanding of the ways in which people think and of the ways novice and experienced teachers alike attempt to make sense of the world. Because the shape and scope of knowledge is ever changing, novices needs to be encouraged to be risk takers and flexible thinkers. In the past, education has presupposed that success in life comes with mastery of fixed content. This study implies, however, that the shape of new curriculums might well mirror the shape of human understanding without fixed beginnings or endings. (LJL)

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Novice Teachers' Ways of Knowing

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Presented at the Annual Meeting of the
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Theoretical Framework

Originally, research in the area of conceptual change focussed on categorizing students' misconceptions of science (see Helm and Novak, 1983; Anderson and Smith, 1983; and Osborne and Cosgrove, 1983). In this literature there was an implicit assumption operating where the false beliefs were seen in need of correction if the students were to achieve a 'scientific' understanding. The unstated intention was to correct the students' misconceptions and replace them with conceptual understandings that match, more closely, the accepted scientific account of the phenomena in question.

Inherent in this conceptualization of conceptual change are philosophies of science, embedded in epistemology. The philosophy of science tends toward a form of positivism where reality is external to the knower, it exists on its own, and facts are to be discovered. Knowledge is directly related to observable propositions and the 'rightness' of the knowledge is to say that it captures an aspect of reality. Truth is reality verification. When science is conceptualized in this way, a major goal is to discover universal laws of truth and reality so that explanations about the world become possible. In transposing a positivistic world-view on to education, teaching frequently takes on a 'how to' approach where knowledge is taught as if it were certain and students are led to accepting such knowledge uncritically.

Some of the shortcomings of this position, particularly with respect to education, are the fragmentation of knowledge, the limitation of

knowledge to within one way of knowing, the inherent denial that all knowledge is value-laden and perhaps most crucial is the exclusion of the role of social reciprocity in knowledge formation. Eisner (1991) captures the essence of these shortcomings in his recent work on qualitative research when he states, "The belief that only through a standard prescribed procedure can a useful description, interpretation, or evaluation of the world be secured dismisses what novelists, film makers, historians, and anthropologist's have provided through their works. The most important work in these fields depends upon personal insight and interpretation, not simply following a set of replicable procedures" (p. 50). In effect, Eisner argues for multiple ways of knowing and in so doing he rejects the possibility of absolute, true knowledge.

Prior to the rejection of absolute knowledge, science was held in an exalted position where it served as the standard for judging knowledge in the Western intellectual world. In serving as the standard, science was seen as a true body of knowledge which was justified by the empirical processes associated with 'scientific' investigations. This exalted view of science has been under attack for an extended period and current views of the philosophy and sociology of science question the basis of achieving absolute knowledge. According to Eisner (1991), "Richard Rorty and the later Stephen Toulmin are also among those who recognize the multiple ways of knowing; each has 'given up' as a mistaken ambition the aspiration to achieve episteme - true and certain knowledge. Belief, says Toulmin, is about as good as we can ever get" (p. 4).

Contemporary philosophical views cast science as a cognitive process which is evolutionary. Development in science is understood to be an evolutionary process (Hull, 1988) where scientists accept, reject or ignore

ideas according to selection processes. Such selection processes determine the notion of conceptual change that is taken to be true at any given time. For Hull, and for us, these selection processes are highly social because scientists "are forced to 'co-operate' in a metaphorical sense with even their closest competitors, i.e., use their work" (p. 514). In addition to science being seen as a evolutionary process, that does not achieve 'truth', it is also conceptualized as a cognitive activity (Giere, 1988). By this, Giere means science is concerned with the generation of knowledge in which people use their mental capacities to interact with their world and make sense of it. A central idea of this cognitive position is the necessity of internal, mental representations for individuals to account for their environment and their interpretation of perceived reality.

In terms of science, Giere (1988) and Hull (1988) adopt a radical position for the generation of knowledge whereas in education, and other social sciences, their position is not extreme. Considering knowledge generation to be a social act can be traced back to the writings of Vico in the 16th century (Von Glaserfeld, 1989). To paraphrase Von Glaserfeld, individuals only know their mental representations of the world because they have generated them in social contexts. Given the social nature of knowledge, an important question is the manner in which conceptual change takes place.

Posner, Strike, Hewson and Gertzog (1982) proposed a theory for conceptual change in which they identified four characteristics that are essential for the development of alternative propositional knowledge. According to them, for conceptual change to take place, the alternative knowledge must be in conflict with the existing propositional knowledge and

the new information must be intelligible, plausible and fruitful. These conditions imply a rationality to conceptual change that is connected to rational learning. Despite the apparent logical connection between the theory and learning, many researchers (Anderson and Smith, 1983; Benson, 1987; 1988; Hewson, 1986; and Osborne and Cosgrove, 1983) argue for the stability of knowledge and the difficulty in having students undergo conceptual change.

Strike and Posner (1990) have revised the original theory of conceptual change in response to the misconceptions literature and the relevance that this literature has to the sociological account of knowledge generation. The revised theory is firmly in the area of conceptual ecology where influential conditions of knowledge generation are contextually dependent. Strike and Posner (1990) illustrate the nature of such conditions when they state, "In the study of conceptual change, we need to note that all the elements have developmental histories and that these histories cannot be understood apart from their interaction with other elements in the learner's conceptual ecology. Our view of conceptual change must therefore be more dynamic and developmental, emphasizing the shifting patterns of mutual influence between the various components of an evolving conceptual ecology" (p. 16). As part of their conclusion, Strike and Posner (1990) identify two areas of research that are needed to further establish the theoretical articulation of a conceptual change research program. These are determining the boundaries of the theory and how it relates to learning, as well as making connections between the theory and cognitive approaches to teaching and learning. These points raise questions about teachers' knowledge and the role such knowledge plays in learning to teach.

Teacher Thinking

A recent survey of the teacher thinking literature (Carter, 1990) identifies three large categories of teachers' knowledge. The first one is termed information processing and this is knowledge of processes that teachers use to identify problems, attend to cues, make decisions and evaluate actions. The second category is practical knowledge and it deals with practical, commonsensical knowledge that arises from practice through reflectivity. It is knowledge derived from practical classroom situations and how teachers carry out purposeful action when they are immersed in a teaching context. The third category is Shulman's (1987) pedagogical content knowledge or what teachers know about their subject matter and how they translate that knowledge into appropriate forms for effective student learning.

The body of literature that represents these three categories focus on what teachers know and how such knowledge is transformed for students. In all of these categories what is being studied are the observable, overt characteristics of congruence between classroom action and knowledge. These studies seek to explain the way that teachers think. The assumptions that these studies are based on are: 1) That teacher knowledge is measurable. In other words, a high degree or level of content knowledge, on the part of a teacher, equates to being a 'good' teacher. For lack of a better description this approach could be termed positivist as it views knowledge in a concrete sequential manner and adopts a position of explaining thinking based on measureable quantities. This sets up a predictable conclusion where the definition of knowledge and possible outcomes are predicted before any test is administered. The prediction is not in a specific manner, but it is predictable in an epistemological fashion.

For example, if knowledge is defined in the manner described above then certain specific claims about what constitutes knowledge and what constitutes thinking, teaching and learning can be stated. It is not the purpose of this paper to refute this or any other approach to theory of knowledge. Rather, the purpose, as we see it, is to provide an alternate "way of knowing" or epistemological path to teachers' knowledge and conceptual change. 2) The second assumption that previous studies have held to be 'true' holds a direct correlation between what a teacher says and what a teacher is. This paper wants to suggest that while listening to teachers' voices is imperative, the act of "listening" may be a naive one, one which in fact disempowers teachers' voices rather than empowers them. Throughout the history of the literature on teachers' knowledge, researchers have attempted, in varying ways, to listen to what teachers have been saying. It is our view that what teachers have been trying to articulate in the last ten or so years is the way that they conceive of, make sense of, and cope with conceptual change. Studies which have listened to teachers' talk and teachers' narratives have assumed that what teachers are saying in their narratives were an accurate description of teacher knowledge and that these narratives gave voice and, therefore, meaning to the special insights that teachers have about the world they live in. This paper suggests that while the study of personal knowledge is intriguing and valuable it does not, nor cannot capture an understanding of the way in which teachers think. Our study seeks to understand the presuppositions that underly novice teachers' ways of knowing. By laying out these presuppositions we believe we can understand how it is that novice teachers and experienced teachers alike attempt to make sense of the world. In other words, the narratives of personal knowledge, and similar

studies on teacher knowledge, serve as a basis for understanding 'why' teachers think the way they do. For us presuppositions are those beliefs, or a set of beliefs, that are taken to be true by a given group. These presuppositions are relevant to time and place. Therefore, we can characterize the way that teachers have "seen the world" epistemologically in the last hundred or so years fairly accurately. We might, as suggested above, describe these presuppositions as postivistic. More specifically, we could say that education has been seen as conforming to a factory model which presupposes that knowledge equates to content mastery and that success in life equates to mastery of content. Within this presuppositionary set of beliefs about the world is also a prescribed set of questions which generally begin with 'what', 'how' and 'when'. These questions themselves prescribe the type of answers that epistemological studies address. If personal knowledge or any other mode works within this set of presuppositions then the results of any study on epistemology or conceptual change will seek to explain how it is that teachers think or see change the way they do.

We want to suggest that the set of relative presuppositions which have served to explain 'how' people think can and should be used to understand 'why' people think the way they do. Specifically, if teachers' narratives can be understood as a set of relative presuppositions then the way that the teachers conceive of change and their place within that change amounts to a paradigm. In this study, we want to address the issue of conceptual change from that point of view.

The Study

The study is situated within a program that examines the design and conduct of curriculum methodologies for intending elementary teachers. The

program normally enrolls approximately 250 students in multiple sections in any given year of the B.Ed. degree. The graduates of the program are understood to be generalist teachers with a major emphasis in one discipline but they are required to take instruction in the methodologies of English, mathematics, science and social studies. The 117 students involved in the study represent 6 sections of program in the professional year; it is during this year that student teaching occurs. Of the 117 participants, 68% are undergraduate B.Ed. (4 year) students and 32% are after degree students (taking a B.Ed after a first baccalaureate degree). The composition of the group in terms of gender is 84% female and 16% male.

All students in the study are in a professional year in which all of their course work is compressed into two blocks of time; a 10 week period in the fall term and a 7 week period in the winter term. Also, there are two full-time student teaching terms; a 4 week session takes place immediately after the fall term and an 8 week session that takes place after the winter term.

Method

A two part set of questions was developed to determine novice teachers' conceptions of knowledge and their beliefs about teaching. Part one consisted of the epistemological section and it contains 25 items making epistemological claims (e.g. The truth of an idea is determined by the degree of correspondence between an observation and the phenomena). This part of the instrument was designed to investigate novice teachers' beliefs about the basis of knowledge, and the status of knowledge claims (e.g. absolutist, contextualist, relativist, etcetera). Part two, consisted of the pedagogical section and it contained 15 items making

pedagogical claims (e.g. The main reason for content is to give the teacher a basis for evaluating students). This part of the instrument was designed to investigate novice teachers' views on teaching and learning. The items in both parts were scored on a 4-point Likert scale (Strongly Agree, Agree, Disagree, and Strongly Disagree). The set of questions was administered to the participants twice. The first testing took place at the completion of the fall term which was immediately prior to having the students go out to the schools for the 4 week student teaching session. The second testing took place at the completion of the student teaching experience and immediately prior to the resumption of university classes for the 7 week winter term.

Analysis of Data

A factor analysis of items on conceptions of knowledge and views on teaching and learning resulted in the identification of four factors (see Tables 1-4). A varimax rotation was performed where a factor loading of .400 to .650 was considered moderate and a loading greater than .650 was considered high. The loadings are reported for individual items in the tables and they range from .402 to .599. There are three factors about the conceptions of knowledge, including the truth of knowledge, the certainty of knowledge, and the stability of knowledge. The fourth factor is about views of teaching and learning and whether or not students generate individual meanings of the world.

To determine the influence that the student teaching experience had on the items, comprising the four factors, a t-test was calculated. A value of one (1) was assigned to the Strongly Agree (SA) response and a value of four (4) was assigned to the Strongly Disagree (SD) response. Table 5

reports the change in students' conceptions of knowledge and views about teaching from the first to the second administration of the set of questions.

Results

The data in the three factors dealing with the students' conceptions of knowledge (Ktru, Kcert, Kstab) suggest that they disagree with the idea of knowledge being equated with observable, measureable facts and because it reflects reality it is considered true. They also disagree with the idea that the curriculum should stress factual content. In terms of the certainty of knowledge, students suggest that knowledge is not consistent from person to person and that science does not result in absolute truth. In addition, the students do not believe in the stability of knowledge created by science. By disagreeing with the items that make up these three factors, the students are rejecting a positivistic interpretation of the world and they are adopting what we term a neo-pragmatic view of the world. This view seems to allow them to work in two paradigms at one time and they have the ability to generate understandings that fit their situations. This ability is demonstrated in the fourth factor (Lcon) where the students move toward the strongly agree position about people generating individual meanings of the world. By attributing a label to the university students as neo-pragmatists, we create a difficulty. We should not label the students because they do not see themselves as being any different than other members of the community in which they find themselves. The only reason we attribute a label to them is in order that we are able to discuss their 'ways of knowing'. The label allows others to comprehend what we are characterizing as conceptual change. The label opens up the possibility of

a dialogue and what we are doing is explicitly describing how a group of people understand their world. In this way, we are making the relative presuppositions of a group of teachers known.

The results of our set of questions, and also research on teacher narrative, suggest to us that a different set of relative presuppositions are being postulated by novice teachers than was the case of teachers adopting the factory model, or positivistic, set of presuppositions. If this is, so then teacher talk may more fruitfully be viewed as an attempt by teachers to make sense of their world. This attempt at understanding is, the formulation of a new paradigm and teachers because of societies' attachment to the old set of prescriptors, are caught between the fragmenting view of knowledge held by the public at large and by themselves. It may well be the case, in fact we believe it to be so, that no one accepts the presuppositions that we have characterized above. However, because we live in a period of rapid change and uncertainty, the old set of presuppositions may still be voiced as true. This makes teachers very vulnerable and their teaching lives chaotic. Their life experiences in school and in their private lives has indicated to them that learning and change do not occur as they believe, it occurs inside the classroom. Therefore, novice teachers and experienced teachers alike may hold on to two sets of beliefs, or hold on to two paradigm beliefs. They may realize that learning and change occur in one way, but they may adopt another set of presuppositions to explain it, or to transmit it to their students. This is what we believe our study has pointed out.

We are trying to understand or make-sense-of as opposed to explaining effective teaching and, therefore, understand the nature of knowledge. We characterize knowledge as an on-going process with no definite beginning

nor ending. Conceptual change in this account is gradual and it takes place within a given set of presuppositions. However, when a significant number of presuppositions change over time, a new or different set of presuppositions form a new or different meaning of knowledge. This process, because it is ongoing and not static, means that paradigm shifts are less likely to be cataclysmic. In most cases, such as the one we describe in this paper, various sets of beliefs exist at the same time. These different sets offer different explanations of the world. Our role is to characterize the type of change and the character of the change as opposed to defining it as technical knowledge which is verifiably true, static, observable and predictable.

Previous studies on teacher knowledge and conceptual change have been looking for observable and predictable change in teaching actions. These changes have been taken to be a description of knowledge. If the actions of the teacher are congruent with the presuppositional set of the researcher then a claim is often made that 'knowledge' has been exhibited, achieved or gained. This is generally what has taken place in formal learning, and it serves as a definition of measurement and evaluation. We also feel that the same observations can be made about research into teacher knowledge. In an effort to empower and understand teacher knowledge the researcher may be reinforcing his or her own understanding of the nature of knowledge.

If knowledge and change are expanded to take into account different presuppositional sets then the teachers' roles could be expanded into allowing students to understand the reasons why they see the world in a particular way. Therefore, a lack of conguence between teacher and student, or teacher and researcher may demonstrate a different

presuppositional set of beliefs. This may lead to a teacher exhibiting a different action and adopting a different explanation of the nature of teaching knowledge as well as a different meaning for what it 'means to teach'.

In our study, conceptual change might best be understood as a dialectical change of paradigms. It would seem that novice teachers construct their view of the world in a neo-pragmatic manner yet are willing to use positivistic means to teach their view of the nature of knowledge. Seen in another way, teachers adopt one set of presuppositions in terms of teaching technique while adopting a different set of presuppositions to construct their meanings of the world. It may be that teachers dip back into a previous set of presuppositions for purely technical reasons while encouraging their students to generate individual meanings of the world in which they live.

Previous studies in the area of teacher knowledge and conceptual change have characterized change within a given paradigm or set of relative presuppositions. This could be the case for studies in the area of personal knowledge. Perhaps what our study indicates is that conceptual change is also occurring from one paradigm to another. The attempt to understand teachers' voices and teacher talk within this description could be seen as an attempt to yield empowerment for teachers in their attempt to understand the nature of knowledge, and their role in promoting constructive change. Within this new paradigm, we believe that teachers are attempting to have students think about thinking. They might not be consciously aware that they are doing this. At this point they are not able to voice or articulate their desire to make students cognitively aware of the metacognitive processes that are being used and the reasons why

students are using them in forming relationships amongst concepts. However, the data that we received from the survey suggests this may be a possibility.

Implications

There are many implications for student teaching that can be drawn from our study. Among them are: 1) The nature and definition of knowledge that is taught, 2) The role of the teacher in dealing with change within formal education, 3) The shape of the practicum and its evaluation, 4) The shape of future curriculum.

First, if we are correct in describing knowledge as a process, without a definite beginning or a definite ending, in which change occurs through a dialectical pattern where opposites do not clash to yield a resolution, but rather change occurs over time as the nature of the presuppositional set changes; then we as teacher educators and researchers need to rethink what we are saying to novice teachers about content and change in the classroom. It might, for example, be more productive to trace the way that knowledge has changed rather than to explain it. It might also be more productive to trace out the varying presuppositional sets which have characterized different ways of knowing about the world. However, if one wants to characterize this, it is clear that we need to view the world as a historical progression of ideas in which ideas from the past represent the ways in which people thought about the world and their reasons for doing so. It is also clear that such a study places knowledge of the past into a different relationship with the present. We think the way we do today because of the way that people thought about the same questions in the past. Therefore, the shape and scope of knowledge has

changed rather dramatically. Not only does epistemology become an ongoing study of process, but also it becomes human centered. It is "I" as learner who makes sense of the past and of the present. This link between past and present is also our insurance that epistemology does not lapse into naive relativism. This is because facts are selected in a relative fashion - relative to the question asked - the process of knowing, the way of knowing is the same. Therefore, knowledge becomes more than factual content. It becomes the understanding of the way in which we think.

The second factor is the role of the teacher in dealing with change in formal education. If one agrees with our characterization of knowledge as process and with our notion of paradigms then the role of the teacher, be it novice or experienced, falls in line with the results that we see in our study. Our novice teachers see themselves as agents of change. They are prepared to use the tools of a technical, positivistic view to enable their students to apply different tools to construct individual meanings of the world. The novice teacher, on this account becomes an important factor in the educational process; she/he brings an increasingly different view of knowledge and the role of the teacher. The experienced, co-operating teacher becomes the role model in a technical sense, while learning the novice teachers' viewpoint about teaching. In effect, the teaching profession incorporates the novice teacher to reinforce its belief in the new paradigm while sharpening the skills of lateral movement within the old paradigm. Teachers, new and experienced, become partners and facilitators in the process of discovery for themselves and their students. This partnership allows effective ways of making sense of the world become possible.

The third factor that should be assessed is the shape and form of the practicum. If the "acquisition" of knowledge is seen in the way that we have characterized it, then any practicum should be lengthy and ongoing. It would be beneficial, for example, to have ongoing mutual practicum assignments through any teacher training program. Both novice teachers and co-operating teachers would clearly benefit from an ongoing relationship. In this way, novice teachers could be positively inducted into the techniques of teaching. The novice teachers, equipped with insights from methods courses at the university could help the experienced teacher characterize and further understand the process of change that is ongoing within the presuppositional set. The greatest beneficiary, of course, would be the pupils who would be able to 'tap' into the energy of the novice teachers and the experiences of 'master' teacher.

Any evaluation of a novice teacher would be of a different form than used in most, if not all, teacher training programs today. Given the results and arguments presented here, it makes no sense to train, or indoctrinate teachers into a static mold. Rather, novice teachers would be expected to be risk takers, flexible thinkers and caring, empathetic individuals. If these characteristics are present then a second evaluation at a later date on formal technical skills could take place. It could be assumed that this latter set of skills would be easier to master than the former epistemological point of view.

The fourth point is the shape of any future curriculum. Perhaps the greatest change to occur in any future educational system might be the shape and scope of any formal curriculum. In some respects, issues like content could be easily resolved. If all knowledge is historically derived, then the acquisition, the understanding, of content is essential.

However, questions as to how to measure, what to measure and whether to measure content are not clear, and would present some serious worries for teachers, parents and students.

As well, the necessity and shape of resources would have to be called into question. Could any text based on secondary sources ever help students to understand the world in the way we have characterized it? That seems unlikely. However, one would not want to throw out all standardization and, thereby, have many students suffer at the hands of less adequate teachers. The answer, we believe, lies in closer ties with faculties of education and content faculties which supply 'state of the art' information to students. If university faculties provide new ideas to students of education, they can in turn interpret it epistemologically for the benefit of experienced teachers and their students. The shape, therefore, of any new curriculum might well mirror the shape of human understanding - ongoing non-static and without fixed beginnings or endings.

TABLE 1

Factor Analysis of Conceptions of Knowledge About the Truth of Knowledge (Ktru)
(- indicates reverse loading)

Item #	Items that loaded most heavily on Ktru.
14	The world is made up of observable facts that are capable of being understood, measured, explained and predicted. (.452)
20	Knowledge varies from one historical era to another. The only way to judge the truth of ideas is to interpret them according to the present culture. (.402)
30	The truth of an idea is determined by whether or not there is a direct correspondence between the observations and the explanation of the phenomena. (.444)
41	The content that should be taught in schools should be factual, measureable and predictable. (.467)
44	The main reason for content is for students to learn the knowledge of the world. (.449)

TABLE 2

Factor Analysis of Conceptions of Knowledge About the Certainty of Knowledge (Kcert)

(- indicates reverse loading)

Item #	Items that loaded most heavily on Kcert
16	A universal solution can be found to every dilemma. (.571)
19	Knowledge is consistent from one group of people to another, or from one culture to another. (.448)
22	Scientific theories describe the world as it really is. (.493)
23	Thanks to science, knowledge is known with certainty. (.527)

TABLE 3

Factor Analysis of Conceptions of Knowledge About the Stability of Knowledge (Kstab)
(- indicates reverse loading)

Item #	Items that loaded most heavily on Kstab
13	Scientific knowledge should be about practical facts not theoretical ideas. (.537)
18	In conducting an experiment, the researcher's actions are separate from the morality of the situation. (.465)
29	Explanations for events are consistent over time. (.538)

TABLE 4

Factor Analysis of Views of Teaching and Learning About Constructing Meaning (Lcon)
(- indicates reverse loading)

Item #	Items that loaded most heavily on Lcon
42	A major function of education is to make the young responsible, productive citizens. (.559)
47	Students in a social studies class construct individual meanings of the world. (.599)
48	Students in a science class construct individual meanings of the world. (.466)
49	Students in a language arts class, studying Shakespeare's Macbeth, construct individual meanings of the text. (.479)

TABLE 5

Changes in Students' Conceptions of Knowledge and Views about Teaching
(* indicates significance p = .05)

Item	N	Mean($\bar{x}$)	Difference($\bar{x}$)	S.D.	t-value	P
Truth of Knowledge Factor (Ktru)						
First 14	116	2.4397	-0.1897	0.768	-2.66	0.009*
Second 14		2.6293				
First 20	115	2.7043	0.1304	0.864	1.62	0.108
Second 20		2.5739				
First 30	116	2.4483	0.0431	0.690	0.67	0.503
Second 30		2.4052				
First 41	117	2.9744	-0.0085	0.689	-0.13	0.893
Second 41		2.9829				
First 44	115	2.3043	0.0348	0.712	0.52	0.602
Second 44		2.2696				
Certainty of Knowledge Factor (Kcert)						
First 16	116	3.0345	-0.0948	0.769	-1.33	0.187
Second 16		3.1293				
First 19	116	3.3190	0.0086	0.775	0.12	0.905
First 19		3.3103				
First 22	117	2.9573	0.0427	0.747	0.62	0.537
Second 22		2.9145				
First 23	117	3.0940	0.0598	0.686	0.94	0.347
Second 23		3.0342				
Stability of Knowledge Factor (Kstab)						
First 13	116	2.5690	0.1034	0.784	1.42	0.158
Second 13		2.4655				
First 18	117	3.2222	-0.0085	0.701	-0.13	0.895
Second 18		3.2308				
First 29	117	3.2821	0.0684	0.716	1.03	0.304
Second 29		3.2137				

Learning about Constructing Meaning Factor (Lcon)

Item	N	Mean($\bar{x}$)	Difference($\bar{x}$)	S.D.	t-value	P
First 42	117	1.7778	0.0769	0.575	1.45	0.150
Second 42		1.7009				
First 47	114	2.000	0.0702	0.474	1.58	0.117
Second 47		1.9298				
First 48	114	2.1930	0.0175	0.691	0.27	0.787
Second 48		2.1754				
First 49	115	2.0957	0.0696	0.573	1.30	0.196
Second 49		2.0261				

REFERENCES

Anderson, S.W. & Smith, E.L. (1983). Children's conceptions of light and color: Developing the concept of unseen rays. Annual Meeting AERA, Montreal.

Benson, G.D. (1987). Cognitive Conflict and Science Conceptions. Annual Meeting of The National Association for Research in Science Teaching, Washington, D.C.

Benson, G.D. (1988). Reflection on Curriculum: Conceptual Change in Elementary Science Students. Annual Meeting of the The Canadian Society for the Study of Education, Windsor.

Carter, K. (1990). Teachers' Knowledge and Learning to Teach. In W.R. Houston (ed.) Handbook of Research on Teacher Education. New York: MacMillan, 291-310.

Eisner, E. (1991). The Enlightened Eye. New York: MacMillan.

Giere, R.N. (1988). Explaining Science: A Cognitive Approach. Chicago: The University of Chicago Press.

Helm, H. & Novak, J. (eds.) (1983). Proceedings of The International Seminar on Misconceptions in Science and Mathematics. Cornell University, Ithaca, N.Y.

Hewson, M.G. (1986). The Acquisition of Scientific Knowledge: Analysis and Representation of Student Conceptions Concerning Density. Science Education, 70, 2, 159-170.

Hull, D.L. (1988). Science as a Process. Chicago: The University of Chicago Press.

Osborne, R.J. & Cosgrove, N.M. (1983). Children's Conceptions of the Changes of the State of Water. Journal of Research in Science Teaching, 20, 9, 825-838.

Posner, G.J., Strike, K.A., Hewson, P.W. and Gertzog, W.A. (1982). Accommodation of a Scientific Conception: Toward a Theory of Conceptual Change. Science Education, 66, 2, 211-227.

Shulman, L.S. (1987). Knowledge and Teaching: Foundations of the New Reform. Harvard Educational Review, 57, 1, 1-22.

Strike, K.A. & Posner, G.J. (1990). A Revisionist Theory of Conceptual Change. In R. Duschl, R. Hamilton (eds.) Philosophy of Science, Cognitive Science and Educational Theory and Practice. Albany, N.Y.: SUNY Press.

Von Glaserfeld, E. (1989). Cognition, Construction of Knowledge and Teaching. Synthese, 80, 1, 121-140.